

Technologies Enhance Patient Care – in the community

Professor Douglas Yung Pun To

Breath is composed of a mixture of gases, water vapor and characterized distinctively by >1000 trace volatile organic compounds and protein molecules. These endogenously generated breath biomarkers provide a window into the metabolic state of the body. For instance, exhaled nitric oxide is a biomarker to indicate the severity of respiratory inflammation and exhaled acetone is used to monitor diabetes.

We use molecular imprinted polymer as artificial antibodies to detect breath biomarkers. Molecular imprinting is a process to fabricate a polymer matrix around a target molecule, which is subsequently removed to leave voids with high affinity. Advantages include high sensitivity, temperature stability and low production cost. The synthesized polymer is coated on microcantilevers, which are millimeter-sized beam anchored at one end. Binding of breath molecules with their specific polymer leads to measurable mechanical responses. Breath diagnosis measures various exhaled compounds rapidly and non-invasively, thus enabling on-the-spot clinical screening.

呼氣的成份包括多種氣體、水蒸汽、一千多種微量揮發性有機化合物和蛋白質分子。這些體內產生的標記物反映人體的新陳代謝情況。例如，呼出的二氧化氮反映呼吸道炎症的程度，呼出的丙酮可用以監測糖尿病。

我們利用分子印跡聚合物作為人工抗體，檢測呼氣中的標記物。分子印跡技術先使印跡分子與單體相互作用形成配合物，再在適當環境下合成聚合物，將印跡分子從所合成的聚合物上洗脫掉之後，聚合物基體上將留下與印跡分子大小、形狀相同和官能團能與之互補的納米結構，這些納米結構能夠在後續的再結合過程中識別和專一性結合印跡分子，完成對模板分子的選擇性識別。其優點包括高靈敏度、溫度穩定和低生產成本。合成後的聚合物會塗在微型懸臂電壓傳感器上，這些傳感器是一些微米大小的橫樑，其中之一端固定。當呼吸標記物和與其對應的聚合物粘合時，我們可量度懸臂上所產生之相關力學反應。呼吸診斷可以快速、非侵入性地檢測多種呼出的物質，作為即時即場的臨床檢查。

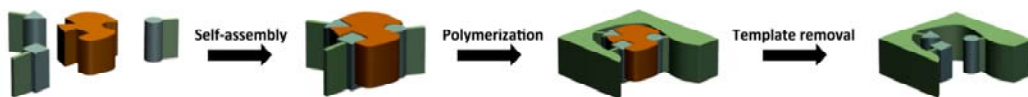


Figure 1. Breath biomarker template (orange) self assembles with functional monomers (green). After polymerization, the template is removed from the polymer, thus leaving binding sites complementary to the template.

圖1. 呼吸標記物的模板（橘紅色）與功能性單體（綠色）自動集合。在聚合之後，模板會從聚合物中除去，所以留下一個可以與模板粘合互補的納米結構。

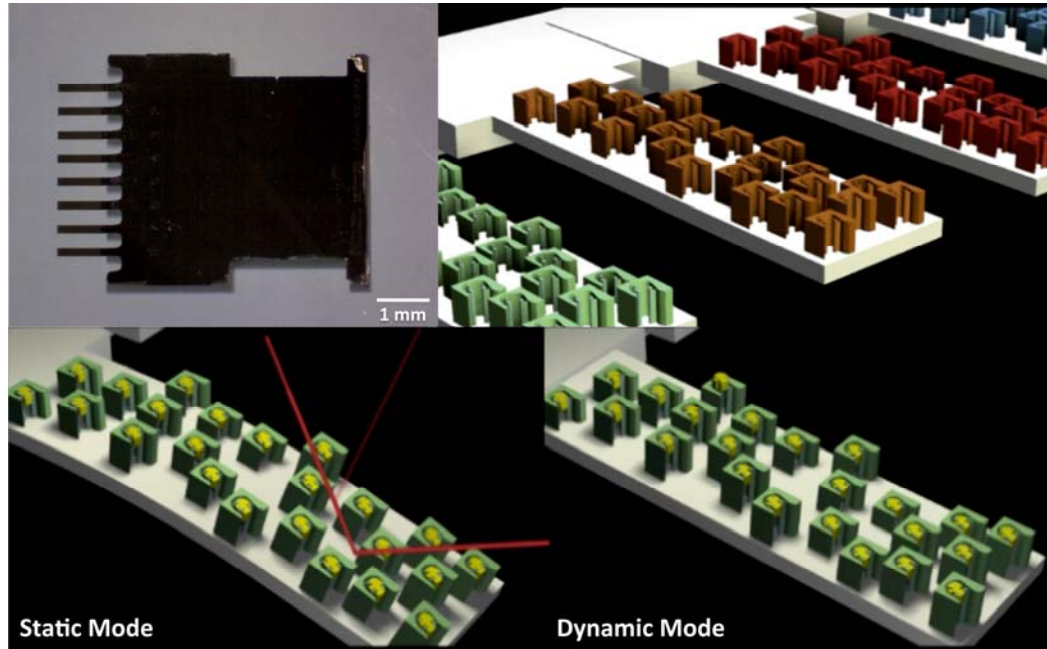


Figure 2. An array of microcantilevers coated with different molecular imprinted polymer detects various target molecules in breath. Mass loading on microcantilevers results in a detectable deflection or broadening in resonance frequency, resulting in two operation modes: static mode and dynamic mode.

圖2. 微型懸臂電壓傳感器組合塗上不同分子印跡聚合物，檢測呼吸中不同的目標分子。懸臂的重量增加會導致傳感器變位或共振變寬，因此有兩種操作模式：靜態模式和動態模式。



Figure 3. The integration of microsensors, piezoresistive transducer, air sampling and integrated circuit systems provide a portable and field-deployable monitoring device for breath diagnosis.

圖 3. 研究團隊把微傳感器、壓阻式傳感器、空氣採樣和集成電路系統結合在一起，提供一個便攜式和可用於實地考察的呼吸診斷檢測儀器。